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## 1 INTRODUCTION

This guidance material has been prepared for use for the definition of protected surfaces in the vicinity of aerodromes.

Survey information for an aerodrome is essential for its effective utilization. The local airspace must be regarded as an integral part of the aerodrome environment. Knowing the location of obstacles and nature of the terrain in the airport environment is essential for efficient and safe air operations.

## 2 REFERENCES

ICAO Annex 14, Aerodromes

ICAO Annex 15, Aeronautical Information Services

Doc 8168 – ICAO Procedures for Air Navigation Services – Aircraft Operations (PANS-OPS)

Doc 9137 - ICAO Airport Services Manual

Doc 8697 - ICAO Aeronautical Chart Manual

Doc 9674 – ICAO WGS-84 Implementation Manual

ASAM No.022 Guidance Material on Positional Data, Preparation and Validation

ASAM No.014 Guidance Material on Aerodrome Annex 14 Surfaces

Aeronautical Information Exchange Model (AIXM) - Obstacle Model Proposal

Eurocontrol Standard for Surveying of Navigation Facilities

EUROCAE: User Requirements for Terrain and Obstacle Data, ED-98

EUROCAE: Standards for processing aeronautical data, ED-76

## 3 DETAIL

### 3.1 Background

Information on the location of obstacles and the nature of the terrain in the airport environment is essential for:

Planning;

New facilities;

Development;

Upgrading;

Operations;



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Approach Procedures;

Departure Procedures;

Publication in AIP;

Ground Movement; and

Take-Off Weight Limitations

This information along with additional navigation data must be available at all times. Aeronautical Charts provide a convenient medium for its publication.

The nature of the operation at any aerodrome will determine the requirements for the various chart types and the extent of the survey information required to be available.

Existing or proposed objects within the aerodrome or in its vicinity are assessed for significance against various protection, limitation or identification surfaces.

### **3.2 Instrument Flight Procedure Surfaces**

These surfaces are used for construction of Instrument procedures and for determining minimum safe altitudes/heights or minimum climb gradients for each segment of a procedure. Minimum safe altitudes/heights will vary with the nature of the operation e.g. aircraft speed, navigational aid and airborne equipment.

#### **3.2.1 PANS-OPS Approach Surfaces**

PANS-OPS approach surfaces are used in the design of instrument approach procedures (IAP's) which are designed to safeguard an aircraft from collision with obstacles during an instrument flight.

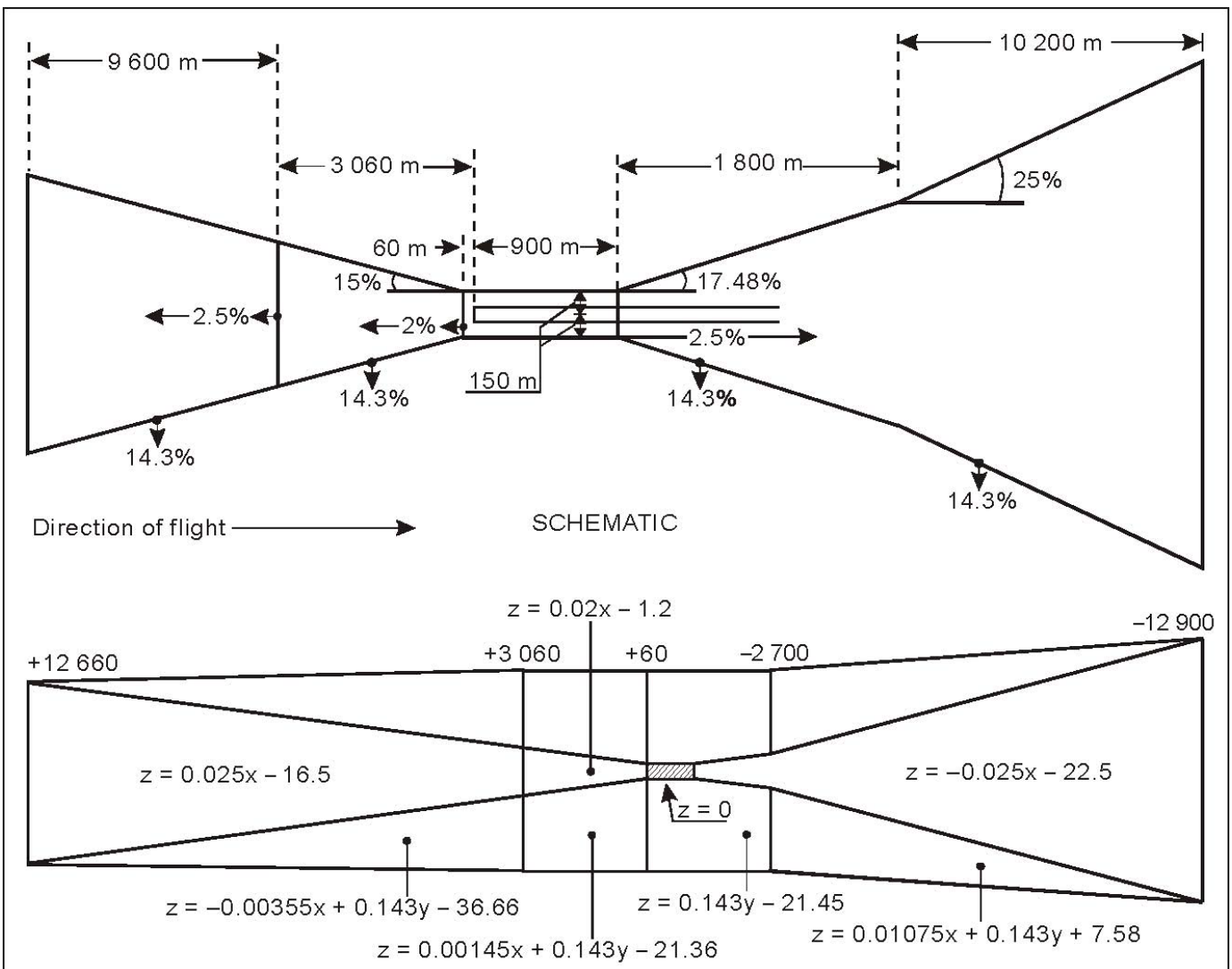
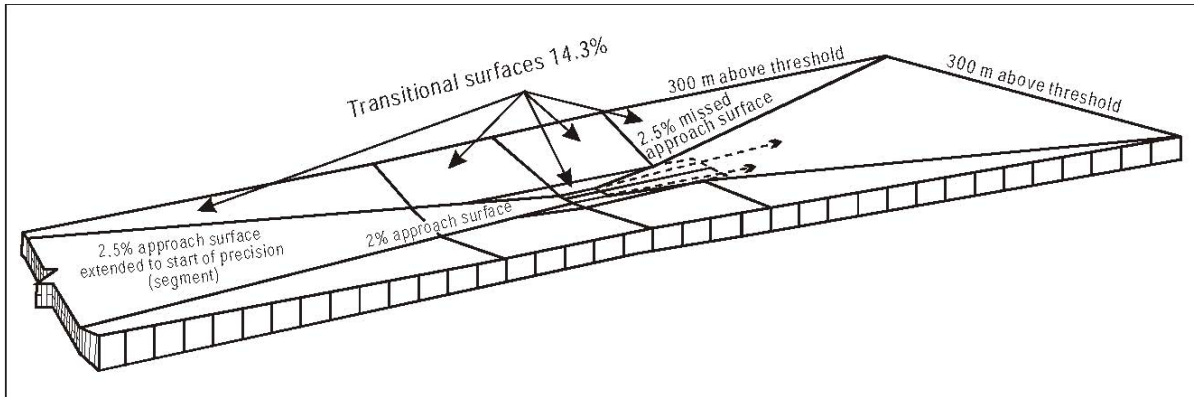
For Non-Precision approaches (two dimensional guidance only) these surfaces are simple. For precision approaches (three dimensional guidance) the obstacle free airspace is more complex. For survey purposes two methods of assessing the obstacle environment for determination of minimum safe altitudes including Obstacle Clearance Altitude/Height (OCA/H) are currently used for precision approaches. These involve the use of the Basic ILS Surfaces and the Collision Risk Modelling (CRM).

### **3.3 Basic ILS Surfaces**

Basic ILS Surfaces represent a simple form of protection for ILS operations. These surfaces define a volume of airspace. Obstacles which penetrate these surfaces become controlling obstacles. The airspace bounded by the basic ILS surface is conservative however, for survey purposes these give an ideal guidance as to which obstacles are relevant for consideration in determining OCA/H using the more sophisticated method of CRM



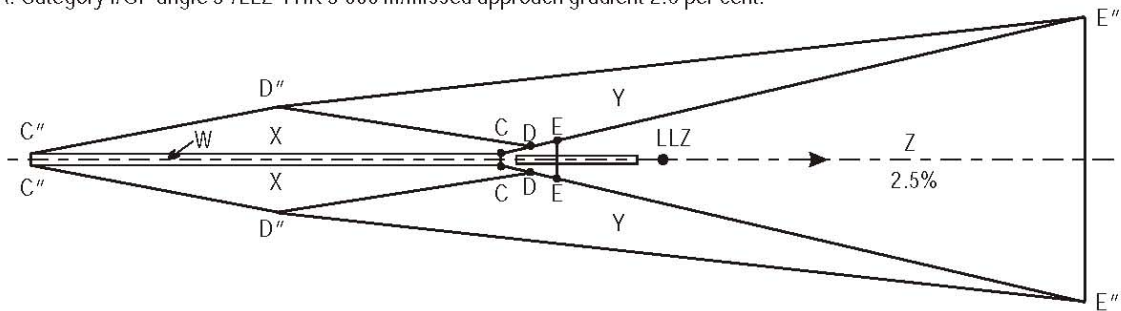
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**Title: Guidance Material on Instrument Flight Procedure Obstacle Surfaces**

A. Category I/GP angle 3°/LLZ-THR 3 000 m/missed approach gradient 2.5 per cent.



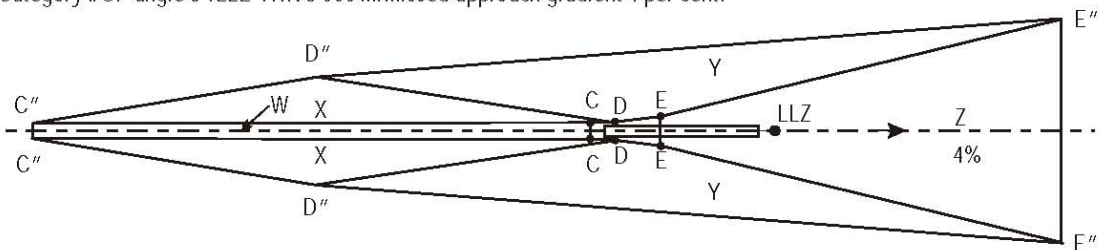
Equations of the obstacle assessment surfaces:

$$\begin{aligned} W | z &= 0.0285x - 8.01 \\ X | z &= 0.027681x + 0.1825y - 16.72 \\ Y | z &= 0.023948x + 0.210054y - 21.51 \\ Z | z &= -0.025x - 22.50 \end{aligned}$$

Coordinates of points C, D, E, C'', D'', E'', (m)

	C	D	E	C''	D''	E''
x	281	-286	-900	10 807	5 438	-12 900
y	49	135	205	96	910	3 001
z	0	0	0	300	300	300

B. Category I/GP angle 3°/LLZ-THR 3 000 m/missed approach gradient 4 per cent.



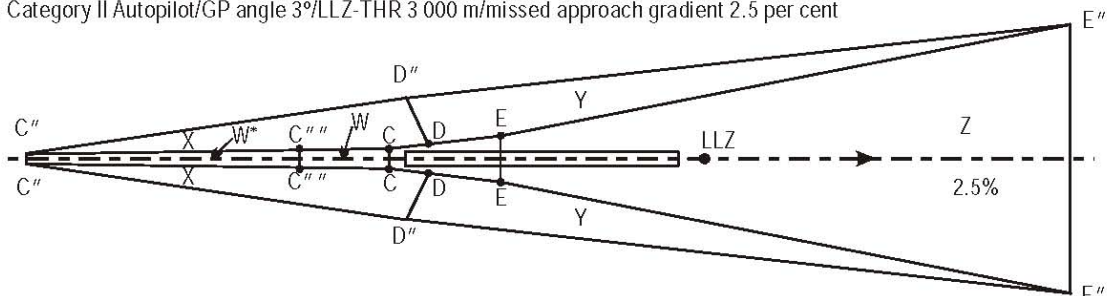
Equations of the obstacle assessment surfaces:

$$\begin{aligned} W | z &= 0.0285x - 8.01 \\ X | z &= 0.027681x + 0.1825y - 16.72 \\ Y | z &= 0.020158x + 0.238021y - 26.37 \\ Z | z &= -0.04x - 36.00 \end{aligned}$$

Coordinates of points C, D, E, C'', D'', E'', (m)

	C	D	E	C''	D''	E''
x	281	-286	-900	10 807	5 438	-8 400
y	49	135	187	96	910	2 082
z	0	0	0	300	300	300

C. Category II Autopilot/GP angle 3°/LLZ-THR 3 000 m/missed approach gradient 2.5 per cent



Equations of the obstacle assessment surfaces:

$$\begin{aligned} W | z &= 0.0358x - 6.19 \\ W^* | z &= 0.042x - 12.39 \\ X | z &= 0.041370x + 0.2752y - 25.32 \\ Y | z &= 0.031955x + 0.280291y - 28.70 \\ Z | z &= -0.025x - 22.50 \end{aligned}$$

Coordinates of points C, D, E, C'', C'', D'', E'', (m)

	C	D	E	C''	C''	D''	E''
x	173	-286	-900	1 000	3 866	-13	-6 900
y	66	135	205	49	55	639	1 424
z	0	0	0	29.6	150	150	150

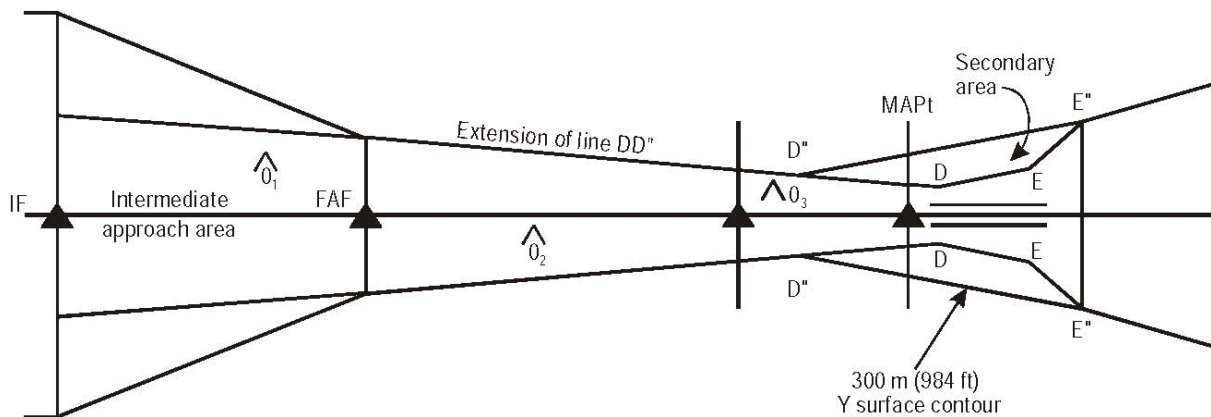
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### 3.4 Localizer/MLS Only Approaches Surfaces

The localizer only procedure (ILS with Glidepath Inoperative) is a non precision approach. The areas for survey are derived from the Basic ILS Surfaces.

The area and profile of the survey required is shown below.

The following dominant obstacles will require survey and scheduling;



- Each obstacle with greatest elevation for the Intermediate, Final, Stepdown and Missed Approach segments.

### 3.5 VOR & NDB Surfaces

#### 3.5.1 VOR

The final approach area is 3.7 km (2.0 NM) wide at the facility and splays at an angle of 7.8° on either side. A secondary area, comprising 25 per cent of the total width, lies on each side of the primary area, which comprises 50 per cent of the total.

#### 3.5.2 NDB

The area is 4.6 km (2.5 NM) wide at the facility and splays at an angle of 10.3° on either side. A secondary area, comprising 25 per cent of the total width lies on each side of the primary area, which comprises 50 per cent of the total.

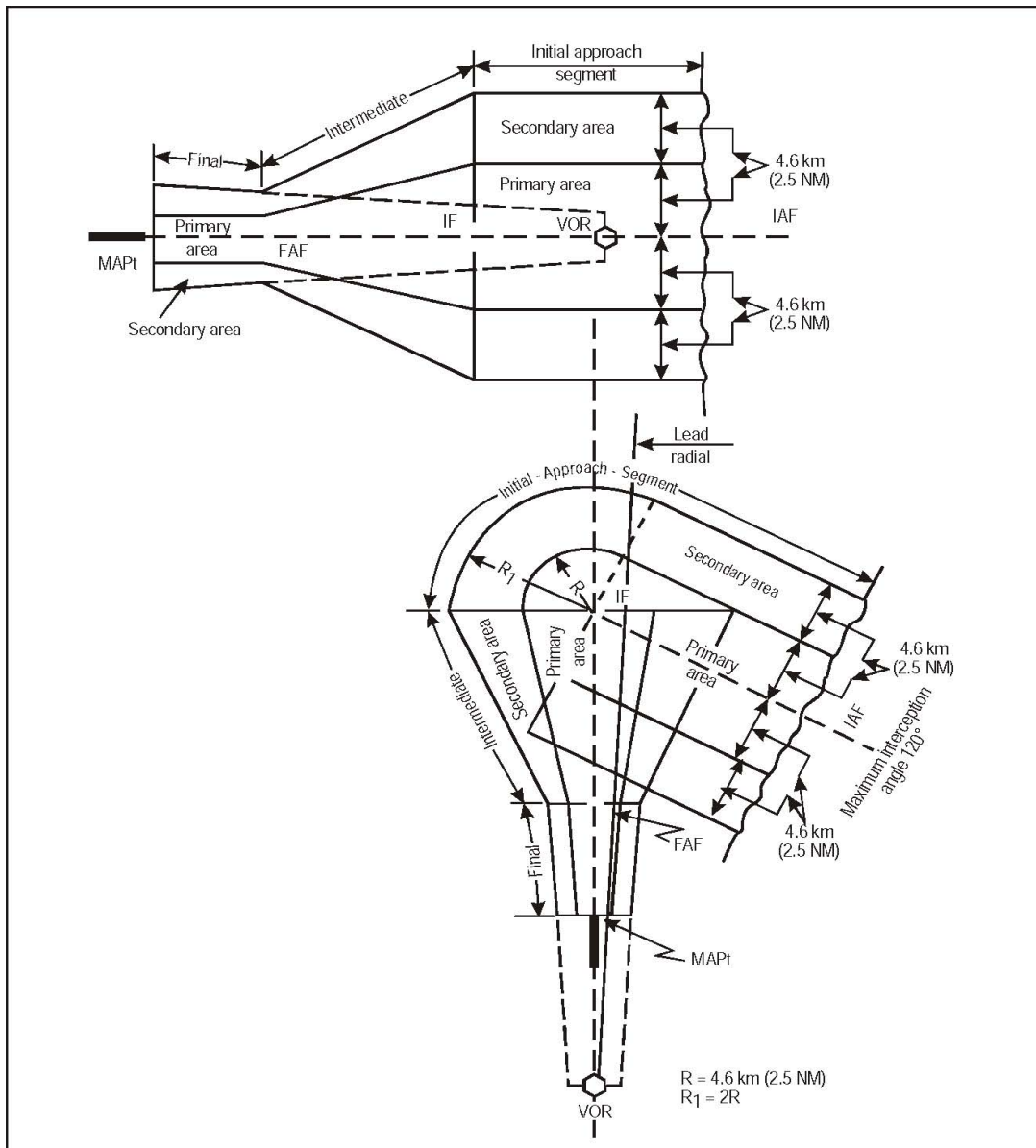
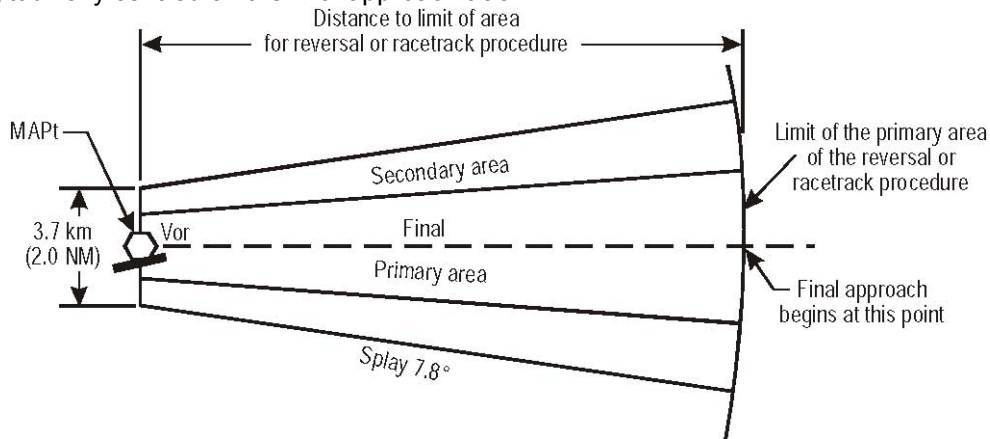


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The illustration above shows the final approach primary and secondary areas for a VOR. The area is longitudinally centred on the final approach track



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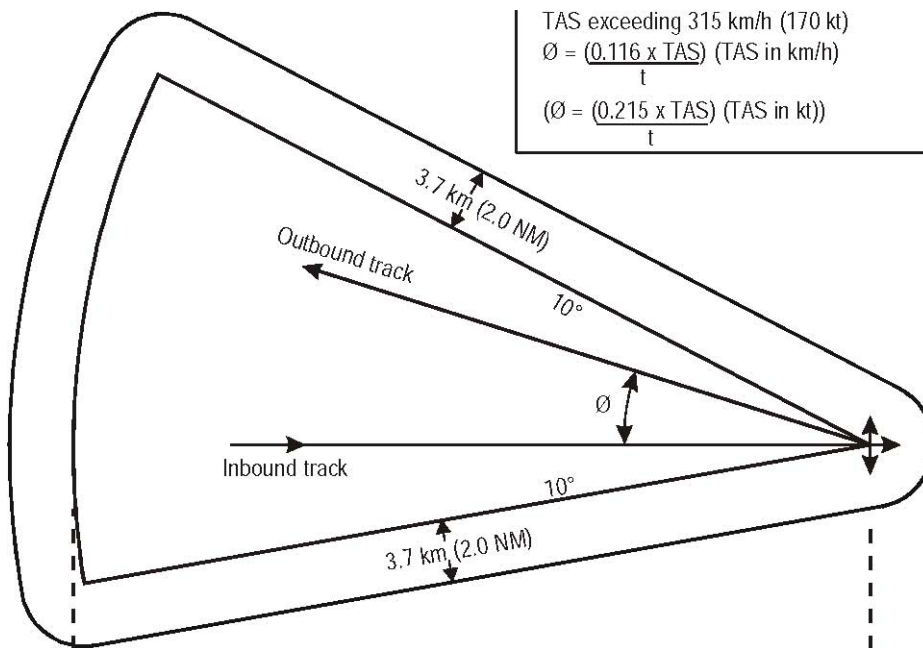
3.6 DF

The area is a sector of a circle centred on the navigation facility, symmetrical about the bisector of the inbound and outbound tracks, with an angle of:

- a)  $20^\circ + 36/t$  for Category A and B; and
- b)  $20^\circ + 54/t$  for Category C, D and E aircraft, having a radius D for all aircraft.

D is described by the following equation:  $D = \frac{V}{t}$  where: D = the radius in km [NM] V = true aircraft speed in km/h [kt] t = outbound time in minutes

This sector shall be extended in all directions by a margin of 3.7 km (2.0 NM).



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**3.7 SRE**

For straight-in approaches, the final approach track shall coincide with the extended runway centre line. For circling approaches, the final approach track shall be aligned to cross the aerodrome manoeuvring area or to intercept the downwind leg of the visual manoeuvring (circling) pattern

The area to be considered for obstacle clearance begins at the FAF and ends at the MAPt or the runway threshold whichever occurs last and is centred on the final approach track (see Figure II-2-6-2). The minimum length of the final approach area shall be 6 km (3 NM) (Cat H, 1.9 km (1 NM)). The length shall be established by taking account of the permissible descent gradient. See 6.4.5. The maximum length should not exceed 11 km (6 NM). Where a turn is required over the FAF, Table II-2-4-1 of Chapter 4 applies. The width of the area is proportional to the distance from the radar antenna, according to the following formula

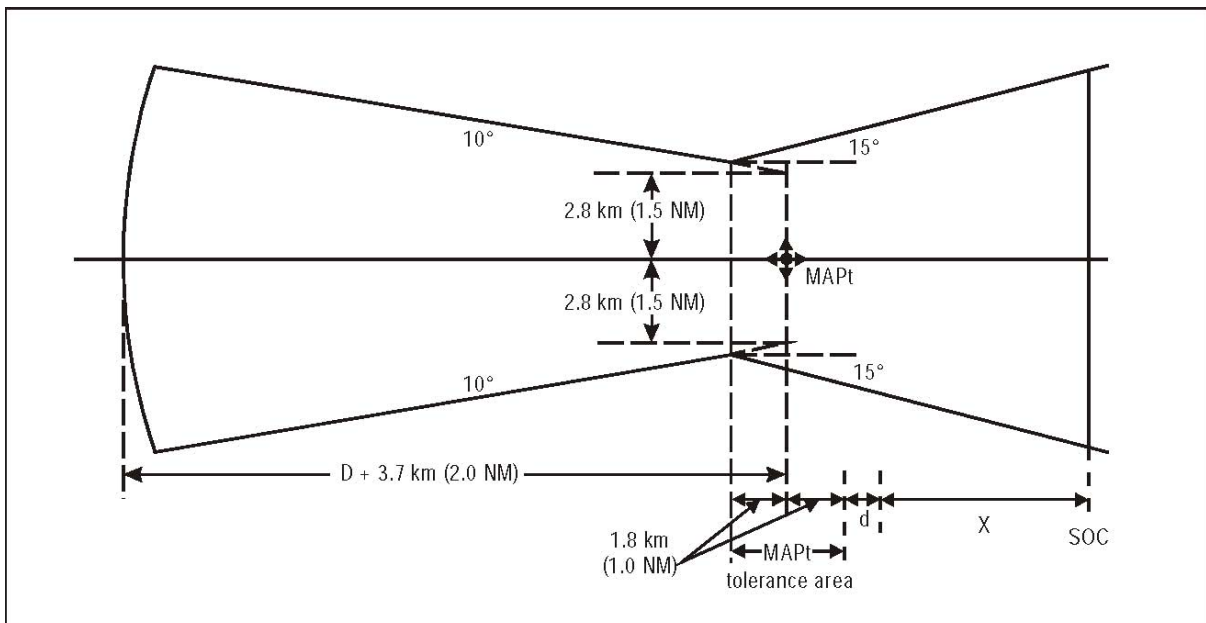
$$W/2 = (1.9 + 0.1 D) \text{ km}$$

$$[W/2 = (1.0 + 0.1 D) \text{ NM}]$$

where: W = width in km [NM]

D = distance from antenna to track in km [NM]

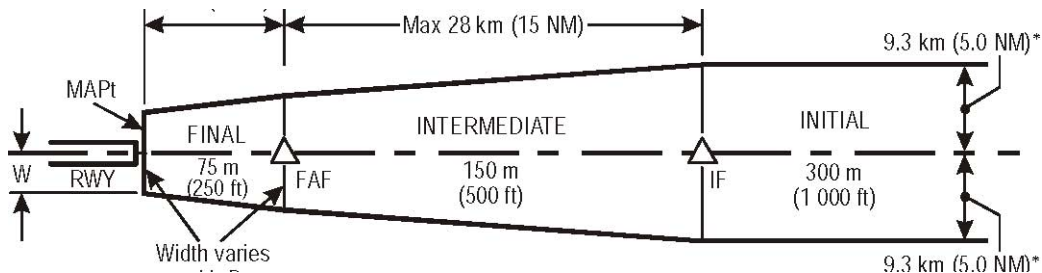
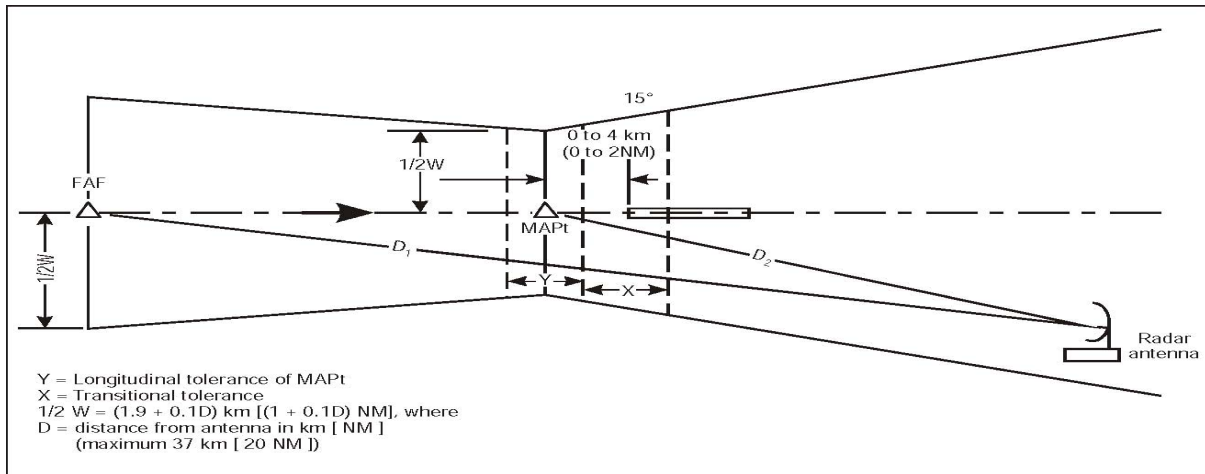
Maximum value for D is 37 km (20 NM) subject to the accuracy of the radar equipment as



determined by the appropriate authority



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### 3.8 ILS Collision Risk Model (CRM)


A computer programme called the collision Risk Model (CRM) can be used to determine OCA/H. Obstacle data is inputted to the programme in terms of geographic co-ordinates and heights, grid co-ordinates and heights or a runway or polar co-ordinate system.

Obstacles for inclusion would be those penetrating the “Basic ILS Surfaces”. Not all of these obstacles may be significant however the CRM programme is designed to exclude those obstacles which do not pose a significant risk of collision.

### 3.9 Obstacle Assessment Surfaces

Obstacle Assessment Surfaces (OAS) may be used to establish a volume of airspace, inside which it is assumed the flight paths of aircraft making ILS approaches and missed approaches will be contained. Accordingly, aircraft need to be protected only from obstacles penetrating this airspace, however, as the dimensions of these surfaces change with the glide path angle and missed approach climb gradient, it is suggested that for initial survey purposes the Basic ILS Surface provides a suitable defined area for consideration.

The area required for follow up surveys may be modified by agreement with the Irish Aviation Authority if required.

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### 3.10 PANS-OPS Departure Surfaces

Departure Procedure Surfaces are used in the design of Instrument Departure Procedures and are referred to as Obstacle Identification Surfaces (OIS).

### 3.11 Obstacle Identification Surfaces (OIS)

These are a set of slopping surfaces. For Straight Departures the origin of the OIS is at the departure end of the runway (DER) at a height of 5m above the DER.

The OIS gradient is 2.5%. It is not possible to specify an area for survey in respect of turning departures in the absence of a specified turning altitude/height, however, a departure area which is common to all current instrument departures is contained below. Obstacle in this area which penetrates the OIS should be included in any initial survey.

### 3.12 Visual Approach Slope Indicator System (OPS)

The principle visual approach slope indicator system used at Irish Aerodromes is the Precision Approach Slope Indicators (PAPI) system.

### 3.13 PAPI System OPS

The use of a PAPI system requires the establishment of an associated Obstacle Protection Surfaces (OPS). Aerodrome Surveys should take account of the OPS associated with the PAPI system.

### 3.14 Mapping

A plan of the survey area should be produced showing the dominant obstacles within the specified segments.

The precise boundaries of these segments may vary between aerodromes. The authority should be consulted before survey is commences to agree the precise details.

A scale plan of the survey area should be produced showing the obstacles. Each obstacle shall be identified by a unique number and include in a schedule to accompany the scale plan.

The procedure designer shall identify the dominant obstacles in the various sectors and details of these obstacles should be extracted from the schedule and included in the aerodrome schedule of obstacles.

Each plan should show the:

- Movement area of the aerodrome;
- Plan position of runway thresholds, localizer and extended line between the localizer and landing thresholds for each runway;
- Runway identifier;
- Plan position and unique reference number if each obstacle;
- Originator's address, qualifications, reference number, date and amendment box.

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3.15 Schedule of Obstacles

The schedule of obstacles which is to accompany each plan should include the following information;

- Geographical co-ordinates (WGS-84) of each runway threshold;
- Elevation of each runway threshold above OD;
- Geographical co-ordinates (WGS-84) of localizer antennae;
- Geographic co-ordinates of the airfield at the date of survey.

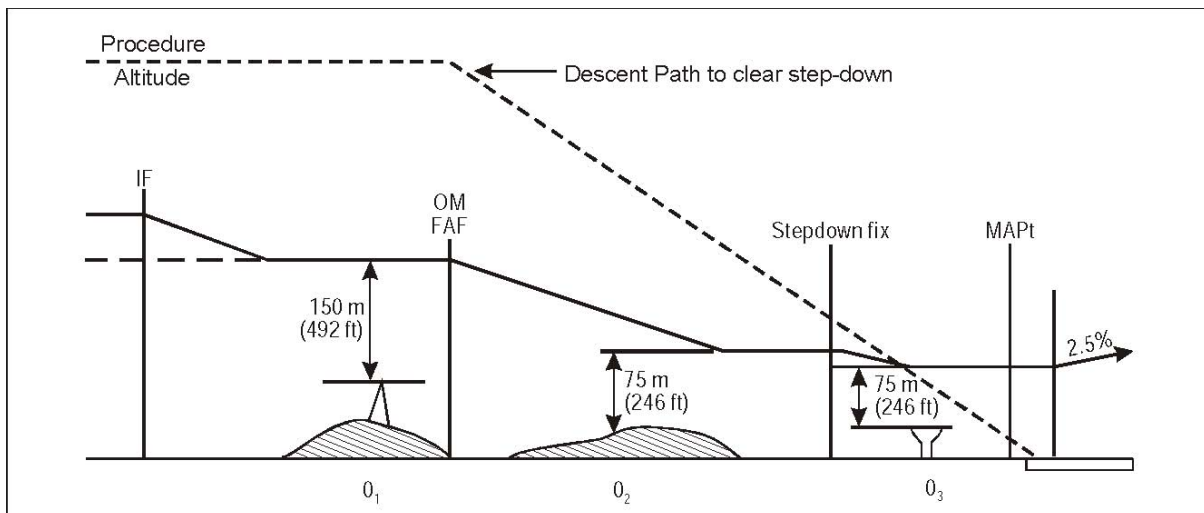
3.16 Obstacle Data

3.16.1 Significant obstacle

Any obstacle or natural terrain which penetrates any of the protective surfaces and has significance for the safety and regularity of aircraft operations are termed in this document as obstacles.


Obstacles may be significant in the context of, inter alia;

- Investigation of need for removal or marking/lighting;
- Requirements to publish in the AIP;
- Establishing OPS for visual approach aids;



- Inclusion in appropriate aviation charts;
- Providing data to enable operators comply with the operating limitations as specified in ICAO Annex 6; and
- Surface movement of aircraft.

3.17 Survey Data

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Precise survey data is required including description, height, location and other detail for all obstacles which infringe the various protective surfaces associated with the aerodrome and its associated facilities (See appendix L)

Additionally data on dominant obstacles over a large area surrounding the aerodrome is required for publication of Minimum Sector Altitude's (MSA's), Visual Manoeuvring Areas (VMA's) and for use in other sections of the AIP. The types of survey requirement which arises within these categorie are specified later in the document.

### 3.18 Schedule of Aerodrome Obstacles

A record of obstacles associated with each aerodrome should be produced as a single schedule of obstacles with a unique numbering system. This schedule should include all obstacles which are significant in respect of the airport facilities in use and obstacle information required for publication on aviation charts, in the AIP and for procedure design should be included.

Plans of the areas should be produced with the obstacles plotted thereon.

A sample of obstacles is included in appendix L.

### 3.19 WGS-84 Implementation

#### 3.19.1 Introduction

The ICAO Council mandated the use of the WGS-84 world geodetic reference system as a standard in March 1989 and declared that by the 1<sup>st</sup> January 1998 all ICAO Member States will use WGS-84 as their sole reference datum for all published aeronautical information.

All Aeronautical Charts, Publications and Data Bases will be required to reflect the new co-ordinae system from that date.


#### 3.19.2 Background

Each country has currently its own unique mapping system and these systems are not compatible or interchangeable. Within each country this is not a problem but when aircraft fly from one country to another, latitude and longitude derived from one country's reference system will provide different positions in an adjacent country. Co-ordinates produced with reference to different datum's for the same geographical position have resulted in reported differences ranging from a few meters to several kilometres.

The WSG-84 Reference System is a global system whose datum centre coincides with the centre of gravity of the earth. The principal active component of Global Navigation Satellite Systems (GNSS) is GPS which uses WGS-84 as the reference datum. With the advent of satellite navigation, very precise and accurate navigation is now possible and discrepancies between position co-ordinates arising from different national datum systems will no longer be acceptable. With the introduction of precision RNAV, which is proposed from 1998, it will be essential to use common accurate position information. WGS-84 implementation is an essential safety requirement for the introduction of precision RNAV operations.

#### 3.19.3 Need to survey

There is a need to survey aerodromes containing instrument runways to establish WGS-84 co-ordinates for runway thresholds, navigation facilities, check points, obstacles, stands, taxiways

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and other miscellaneous items depending on the nature of the aerodrome, its runways, associated navigation facilities and approach/departure procedures.

#### 3.19.4 Surveying

##### a) Initial survey

Initial surveys will require extensive surveying of the entire airport area and its environs to produce the schedule of obstacles and the plans referred to in the section relating to obstacle data earlier.

Note: Following an initial survey for a procedure design it may be necessary to carry out some additional survey work after completion of the preliminary design as it is not always practical to specify a sufficiently large area to cover all possible design requirements without placing an undue burden on the airport operator.

##### b) Periodic Surveys

Follow up surveys shall be required at regular intervals. Additionally such surveys shall be necessary when significant changes occur e.g. the upgrading or lengthening of a runway, the provision of new navigation facilities or to comply with ICAO requirements following an amendment to an Annex or as required by the Authority.

#### 3.20 WGS-84 aerodrome Surveys

Initially it was necessary for each designated aerodrome to establish a local aerodrome survey control network references to WGS-84. This comprised a discrete number of survey control stations monumented in accordance with the requirements of the Eurocontrol Specification standard for Surveying of Navigation Facilities. Subsequently this network will be used to facilitate the WGS-84 co-ordination of obstacles and facilities, thresholds etc. as required.

##### 3.20.1 Survey accuracy

##### a) Facility Surveys

Survey for facilities shall provide WGS-84 co-ordinate data accuracy in accordance with the requirements of the Eurocontrol standard on "Surveying of Navigational Facilities" contained in Table 5.1.


##### b) Obstacle Surveys

Obstacle survey shall provide WGS-84 co-ordinate data accuracy in accordance with the requirements of ICAO Annex 4, ICAO Annex 11 14 and 15 or as specified below, whichever accuracy specification is higher.

Accuracies shall meet at least a 96% confidence level. Reference Point shall be line of origin in respect of an obstacle limitation or obstacle protection surface and elsewhere the aerodrome reference point.

#### 3.21 Height Datum

The height datum shall be Mean Sea Level (MSL). Additionally where measurement of height is an integral part of the surveying technique height data should be recorded for use later e.g. WGS-84 Ellipsoidal Height.

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### 3.22 Quality Control

#### 3.22.1 Quality assurance

All co-ordinates data produced shall be such that the quality can be assured. Self checking survey techniques shall be used at all times and shall be recorded and reported in such a way that the validity of the co-ordinates can be verified.

#### 3.22.2 Traceability

All co-ordinates must be traceable to their source by an unbroken trail which can be followed during audit and evidence shall be presented to confirm that the required accuracies have been met.

#### 3.22.3 Record keeping and auditing

All survey work shall be recorded and reported in a way that the production of co-ordinates can be audited by the authority. Records of surveys shall be maintained for all designated co-ordinates which are for publication in the AIP.

Survey reports shall be provided for all survey work and shall comply with the format included in the Eurocontrol Standard for Surveying of Navigation Facilities.

#### 3.22.4 Use of Existing Survey Data

Where it is proposed to obtain WGS-84 co-ordinate data by making use of existing survey data sufficient survey observations shall be made so as to enable the existing data to be modified to provide data whose accuracy, traceability and quality meet the requirements specified above. Details of such proposal shall be agreed with the authority in advance.

#### 3.22.5 Data presentation

Survey data shall be presented in report format in accordance with the requirements of the Eurocontrol Standard for Surveying of Navigational facilities and shall include where appropriate;

- Schedule of obstacles/points surveyed as appropriate along with the information associated with each obstacle;
- An appropriate plan(s) of the survey area with the obstacles plotted thereon. The appropriate plan may comprise if appropriate an ICAO aerodrome obstacle Type Chart in accordance with the requirements of ICAO Annex 4. The type(s) of plan(s) to be included with the survey report must be agreed in advance of survey with the authority.
- Report information detailed in the Eurocontrol Standard for Surveying of Navigational facilities.

Note; Each plan/chart produced should be uniquely identifiable by drawing number, title, date, origination address. Provision of a tabulated box for the recording of amendments would also be helpful.